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Paper and board — Determination of CIE whiteness, C/2° (indoor illumination conditions)

Papier et carton — Détermination du degré de blanc CIE C/2° (éclairage intérieur)

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 6, *Paper, board and pulps*.

This third edition cancels and replaces the second edition (ISO 11476:2010), which has been technically revised. The major change is to allow for calculations using ASTM E308 for instruments that have bandpass correction and still maintain the non-bandpass-correction procedure.

It is based on the CIE whiteness formula, published in CIE Publication 15:2004, *Colorimetry*.

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Paper and board — Determination of CIE whiteness, C/2° (indoor illumination conditions)

1 Scope

This International Standard specifies the procedure to be used for determining the CIE whiteness of papers and boards, in order to obtain values which correspond to the visual appearance of white papers and boards, with or without fluorescent whitening agents, when they are viewed indoors. It is based on radiance factor data obtained over the full visible spectral range (VIS) in contrast to the measurement of ISO brightness, which is limited to the blue region of VIS. This International Standard also specifies the procedures for the determination of CIE tint values and the fluorescent component of CIE whiteness.

In addition, it specifies a method for adjustment of the UV-content to correspond to that of CIE illuminant C,[10][12] since the results obtained when fluorescent whitening agents are present are dependent upon the UV-content of the radiation falling upon the sample. The CIE illuminant C is taken to be representative of indoor illumination conditions because it contains a suitable proportion of UV radiation.[7] This method is not applicable to coloured papers containing fluorescent dyes. It is specific to the situation where the fluorescence occurs in the blue region of the visible spectral range.

This International Standard is read in conjunction with ISO 2469.

NOTE 1 It is recognized that the CIE whiteness formula was developed in the context of the CIE standard illuminant D65,[5] but the similarity between the relative spectral power curves for the C and D65 illuminants within the visible region and the closeness of their correlated colour temperatures (6 770 K and 6 500 K respectively) are taken as a justification for the use of the analogous whiteness formula with the CIE illuminant C.

NOTE 2 A related International Standard, ISO 11475, specifies the procedure for obtaining values corresponding to the appearance of papers viewed under the CIE standard illuminant D65.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 186, *Paper and board — Sampling to determine average quality*

ISO 2469, *Paper, board and pulps — Measurement of diffuse radiance factor (diffuse reflectance factor)*

ISO 2470-1, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

ISO 4094, *Paper, board and pulps — International calibration of testing apparatus — Nomination and acceptance of standardizing and authorized laboratories*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE The symbols used here are selected to maintain consistency, wherever possible, with the CIE International Lighting Vocabulary ILV. While the definitions used here are based upon the CIE ILV, they have been adapted for this International Standard.

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3.1
reflectance factor
R
ratio of the radiation reflected by a body to that reflected by the perfect reflecting diffuser under the same conditions

Note 1 to entry: The reflectance factor is usually expressed as a percentage.

3.2
intrinsic reflectance factor
R_∞
reflectance factor (3.1) of a layer or pad of the material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured reflectance factor

3.3
diffuse radiance factor
β
ratio of the diffusely reflected radiance of a body in a given direction to that of the perfect reflecting diffuser under specified conditions of irradiation

Note 1 to entry: For fluorescent (luminescent) materials, the specified conditions of irradiation in this International Standard are for CIE Illuminant C and the diffuse radiance factor is strictly the total radiance factor, β, which contains two components, the reflected radiance factor, β_R, and the luminescent radiance factor, β_L, so that

$$\beta = \beta_R + \beta_L$$

Note 2 to entry: For non-fluorescent materials, the diffuse radiance factor, β, is simply the *reflectance factor, R* (3.1).

3.4
intrinsic diffuse radiance factor
β_∞
diffuse radiance factor (3.3) of a layer or pad of the material thick enough to be opaque, i.e. such that increasing the thickness of the pad by doubling the number of sheets results in no change in the measured radiance factor

Note 1 to entry: For fluorescent (luminescent) materials, the intrinsic total radiance factor, β_∞, is the sum of two portions, the intrinsic reflected radiance factor, $\beta_{\infty,R}$, and the intrinsic luminescent radiance factor, $\beta_{\infty,L}$, so that

$$\beta_\infty = \beta_{\infty,R} + \beta_{\infty,L}$$

Note 2 to entry: For non-fluorescent materials, the intrinsic diffuse radiance factor, β_∞, is simply the *intrinsic reflectance factor,* R_∞ (3.2).

3.5
CIE whiteness
W
measure of CIE whiteness derived from the CIE tristimulus values determined under the conditions specified in this International Standard

Note 1 to entry: The CIE whiteness is expressed in CIE whiteness units.

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3.6
green tint
red tint
T_W
measure of the deviation from *CIE whiteness* (3.5) of the test material towards the green or red region under the conditions specified in this International Standard

Note 1 to entry: The deviation is expressed as CIE tint units.

Note 2 to entry: A positive value of T_W indicates a greenish tint and a negative value indicates a reddish tint.

3.7
fluorescence component
F
measure of the extent to which the *CIE whiteness* (3.5) of the material is affected by excitation of the added fluorescent whitening agent (FWA) under the conditions specified in this International Standard

Note 1 to entry: The absence of a suffix in the terms given in 3.5 to 3.7 is used to indicate that the value refers to the CIE 1931 (2°) observer.

4 Principle

The diffuse radiance factor of the material is determined under standardized conditions after adjustment of the instrument so that the relative UV-content of the illumination corresponds to that of the CIE illuminant C, and the CIE whiteness and tint are calculated. The fluorescence component of the CIE whiteness is calculated from the difference between the diffuse radiance factor value and the value obtained when the fluorescence emission from the material is eliminated, for instance, by the introduction into the light beams of a sharp cut-off UV-absorbing filter.

5 Apparatus and equipment

5.1 Reflectometer or **spectrophotometer**, having the geometric, spectral and photometric characteristics described in ISO 2469, calibrated in accordance with the provisions of ISO 2470-1 and equipped with a radiation source having an adequate UV-content and a means of adjusting the relative UV-content so that the measured ISO brightness value agrees with the ISO brightness value assigned to a fluorescent reference standard (5.2.2) and corresponding to the CIE illuminant C. [8][11][12] If a filter (the UV-adjustment filter) is used to make this adjustment, it shall have a cut-off value of 395 nm so that it absorbs UV radiation, but does not, at the same time, alter the visible spectrum within the sphere.

NOTE In order to achieve concordance between the conditions for measuring both ISO brightness and CIE whiteness (C/2°), an adjustment based on a fluorescent reference standard (5.2.2) having an assigned ISO brightness value is preferred.

For the measurement of reflectance factors with the fluorescence effect eliminated, the instrument shall be equipped with a sharp cut-off, UV-absorbing filter (the UV-cut-off filter) having a transmittance not exceeding 5,0 % at and below a wavelength of 410 nm and not exceeding 50 % at a wavelength of 420 nm. The cut-off filter shall have characteristics such that a repeatable reflectance factor value is obtained at 420 nm. The reflectance factor value obtained at 420 nm shall then be considered for computational purposes to be the value which applies at all lower wavelengths, at which it is not possible to make any measurement.

For the measurement of fluorescent papers, photometric linearity up to a scale reading of at least 200 % is necessary in the wavelength region corresponding to the fluorescent emission.

5.1.1 In the case of a **filter reflectometer**, pairs of filters giving the photoelectric detectors of the reflectometer responses equivalent to the CIE tristimulus values X, Y, Z of the test piece,[9] evaluated for the CIE illuminant C[10] and CIE 1931 (2°).[4]

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